Adapting to a Changing Weapons Program

THE successful Spartan antiballistic missile test at Amchitka in the Aleutian Islands got Roger Batzel's tenure as director started with a bang. The test also produced a story that epitomizes his supportive, hands-off managerial style. Phil Coyle, who was later deputy director of the Laboratory, was in charge of the test and asked Batzel if he should send in daily or weekly reports while preparations for the test were under way. Batzel replied that they wouldn't be necessary. "How about monthly reports?" asked Coyle, unable to believe what he was hearing. "No," Roger replied. "You don't need to submit any reports. Just know that we want you to succeed, and we are here to help."

The large nuclear buildup of the late 1960s was over by the time Batzel started as director. The Vietnam War ended not long after, and the entire nuclear weapons complex was soon caught in a budgetary squeeze. Emphasis was on small, tactical warheads with less collateral damage, enhancing the safety of nuclear weapons and continuing the development of strategic deterrent forces. Considerable progress was also made in conventional weapons, including a new conventional hard-structure munition specifically designed to destroy or seriously damage massive reinforced concrete structures such as bridge piers and underground control centers.

Says George Miller, who came to Livermore in 1972 and is now associate director for National Ignition Facility Programs, "Despite the reduction in the weapons budget, the 1970s were a remarkably active period."

In the last years of President Carter's administration our nation's leaders realized that DOE nuclear weapons capabilities had not been adequately maintained, that they needed to be revitalized if the U.S. was going to stay ahead in the arms race. Work started on several new warheads, including the W87 strategic warhead for the Peacekeeper intercontinental ballistic missile, the W84 tactical warhead for the ground-launched cruise missile, and the B83, a modern strategic bomb. These weapons incorporated innovative safety systems, including the new, less sensitive high explosive that is virtually impossible to detonate inadvertently; enhanced electrical nuclear detonation safety; and features to make the weapons safe in the event of fire.

In March 1983, President Reagan unveiled a new vision of national security based on protecting lives rather than threatening them. This announcement kicked off the Strategic Defense Initiative—popularly known as Star Wars—that invigorated weapons work at Livermore during the last years of Batzel's directorship. The Strategic Defense Initiative (SDI) included so-called third-generation, or nuclear directed-energy, weapons. While the long-term goal for SDI was an effective nonnuclear defense, research also continued on promising new nuclear explosive concepts. Design teams began studies of the nuclear-powered x-ray laser as a candidate defense technology and explored the physics of such weapons in underground nuclear tests. In addition, particle beams, the free-electron laser, and other nonnuclear directed-energy weapon concepts were studied on a laboratory scale.

"The crowning achievement of the Strategic Defense Initiative was Brilliant Pebbles," says John Nuckolls, who followed Batzel as Laboratory director. Brilliant Pebbles were to be small, lightweight spacecraft that could stop advanced ballistic missiles and their components in boost phase by colliding with them at high speeds. On command, a global constellation of these nonnuclear spacecraft could detect and destroy missiles without any external help.

Work at the Laboratory on SDI continued into the early 1990s before being discontinued after the end of the Cold War. Technologies developed for SDI were used in numerous later projects. As an example, sensors and cameras developed for Brilliant Pebbles became components of the Clementine moon-mapping project. SDI technologies may also have a role in 21st century missile defense.

Laser Fusion to Study Weapons

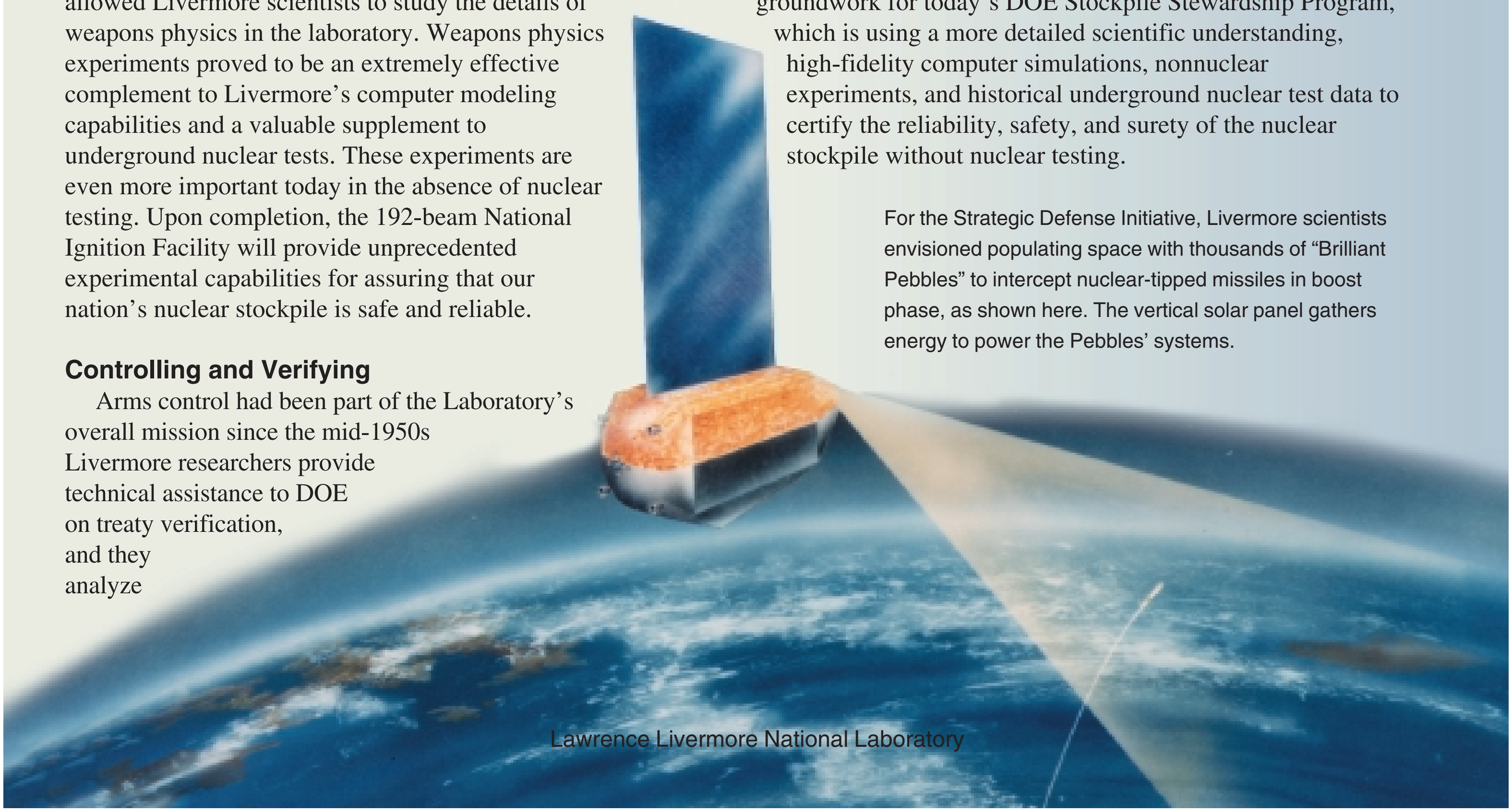
With Batzel's encouragement, the Inertial Confinement Fusion program was formed in 1972 to demonstrate laser fusion in the laboratory and to develop laser science and technology for both defense and civilian applications. First, the Shiva laser and, later, the more powerful Nova laser allowed Livermore scientists to study the details of weapons physics in the laboratory. Weapons physics experiments proved to be an extremely effective complement to Livermore's computer modeling capabilities and a valuable supplement to underground nuclear tests. These experiments are even more important today in the absence of nuclear testing. Upon completion, the 192-beam National Ignition Facility will provide unprecedented experimental capabilities for assuring that our nation's nuclear stockpile is safe and reliable.

Controlling and Verifying

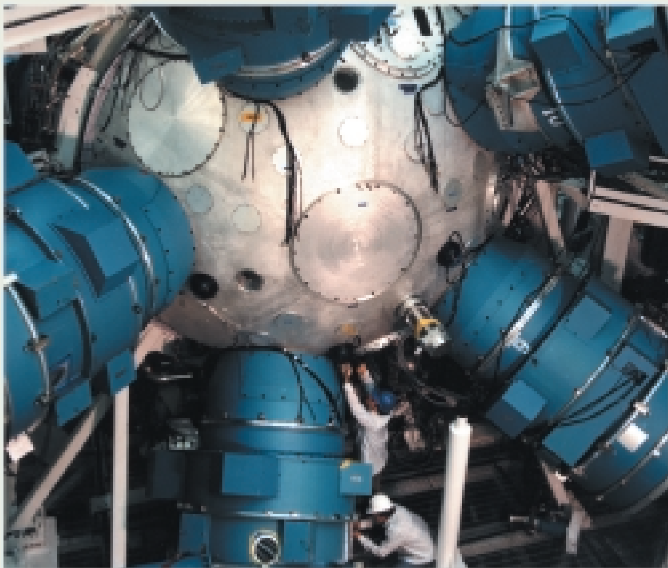
Arms control had been part of the Laboratory's overall mission since the mid-1950s Livermore researchers provide technical assistance to DOE on treaty verification, and they analyze the effects of test-ban and arms control measures on the weapons program and on the nation's nuclear deterrent. While Batzel was Laboratory director, Livermore assisted with continued negotiations between the U.S. and the Soviet Union on a test ban and on a number of arms limitation and reduction agreements.

By 1971, the weapons community knew that a threshold test ban was imminent. The Threshold Test Ban Treaty (TTBT) was signed in 1974 by President Nixon and Secretary Leonid Brezhnev, although it was not ratified by the U.S. Congress until 1990. It prohibited testing of any nuclear weapon whose yield exceeded 150 kilotons. (For comparison, the bomb dropped on Hiroshima had a yield of 15 kilotons.) Between 1971 and 1974, Livermore pursued an accelerated design and test program for weapons exceeding 150 kilotons to gain as much information as possible about those weapons before the treaty went into effect. The delay in ratification of the TTBT resulted in large part from evolving concerns that the treaty was not accurately verifiable.

In the fall of 1977, under President Carter, negotiations resumed after a hiatus of many years on a Comprehensive Test Ban Treaty (CTBT). With the possibility that all nuclear testing might end, Livermore weapon scientists began the research needed to more fully understand the physics of a weapon. Until then, weapon development was based largely on past experience and on improvements that were successful during testing. "In the 1970s, the technical approach to simulating nuclear weapons used many simplifying assumptions because of the limited capability of available computers," says Miller. Research started at this time laid the groundwork for today's DOE Stockpile Stewardship Program, which is using a more detailed scientific understanding, high-fidelity computer simulations, nonnuclear experiments, and historical underground nuclear test data to certify the reliability, safety, and surety of the nuclear stockpile without nuclear testing.



For the Strategic Defense Initiative, Livermore scientists envisioned populating space with thousands of "Brilliant Pebbles" to intercept nuclear-tipped missiles in boost phase, as shown here. The vertical solar panel gathers energy to power the Pebbles' systems.



The target chamber for the Nova laser, which came on line in December 1984. Until Nova was dismantled in May 1999 in preparation for the National Ignition Facility, it was the most powerful laser in the world.

During these CTBT negotiations, President Carter met with Harold Brown, Secretary of Defense; James Schlesinger, Secretary of Energy; Harold Agnew, Director of Los Alamos National Laboratory; and Lawrence Livermore Director Roger Batzel to discuss the ramifications of a ban on nuclear testing. Michael May, who preceded Batzel as director, says, “Lab directors have to tell unpopular truths. Roger always had the respect of people in Washington. His judgment could always be trusted.” No doubt those traits stood him in good stead in this important meeting with President Carter.

Batzel and Agnew explained to the president the need for nuclear testing. Because the weapons laboratories did not yet have a detailed knowledge of the workings of a nuclear warhead, eliminating testing could threaten the U.S. nuclear deterrent. Also, the details of a test ban had not been worked out, particularly with respect to what yield-monitoring threshold the U.S. government could accept.

Since the beginnings of test-ban discussions in the 1950s, scientists had been developing ways to verify that other countries were complying with treaty requirements. Remote seismic monitoring methods were the primary verification tool for years for both a CTBT and the TTBT, but they had limitations. Local geology affects how monitoring systems determine the magnitude of a seismic event and thus the apparent yield of a weapon. While the Nevada Test Site was seismically well calibrated, U.S. scientists had little comparable data on the sites where the Soviets tested their weapons. For a CTBT, the challenge was one of detecting very low-level seismic signals that could be hidden and identifying them as nuclear explosions rather than earthquakes or other events. For a TTBT, the challenge was to deduce the explosive yields from the measured seismic magnitudes, a process generally acknowledged to have a factor of two uncertainty. For example, if the seismic measurements indicate a yield of 150 kilotons, the actual yield could be 300 or 75 kilotons.

Under Batzel, Lawrence Livermore scientists conducted analyses that showed, contrary to the judgment of some policy makers, that within the accuracy of the seismic yield estimates, the Soviets were not violating the terms of the TTBT. The Soviets were observing a yield limit, and that limit was consistent with the 150-kiloton limit of the TTBT. However, a factor of two uncertainty was not good enough for the Administration to press for Senate ratification of the TTBT.

During the latter years of Batzel’s directorship, Livermore and Los Alamos scientists helped the U.S. government negotiate new protocols with the Russians based on the hydrodynamic method for measuring the yield of a weapon test. The TTBT was ratified with the improved protocols in 1990.

A Time of Change

Says Duane Sewell, who served as deputy Laboratory director for several years under Batzel, “Roger believed deeply in building up the strength of the United States.” Most important to Batzel was bolstering national security.

By the end of Batzel’s directorship (1988), Livermore and its sister laboratory at Los Alamos had been instrumental in developing a stockpile in which both the number of weapons and the total yield in the stockpile had been reduced dramatically from the numbers of the late 1960s. Improvements in the design and accuracy of weapons had had their effect. By 1988, the number of U.S. weapons was at its lowest point since the late 1960s, and the megatonnage had been reduced by approximately 75 percent since 1960.

Times change, the world changes, and certainly the Laboratory changed, growing and maturing, under Roger Batzel’s capable leadership. And as it did during the era of Roger Batzel’s remarkable leadership, the Laboratory must continue to evolve to help meet major new challenges, particularly in its primary national security mission.

—Katie Walter

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